Ekliptik d.o.o.

EBS User's Manual

2.2.0.172

CONTENTS

1 User's Manual **1**

2 User Interface **3**

2.1 Mode . . . 3

2.2 Command . . . 3

2.3 Tool . . . 4

2.4 Widget . . . 4

2.5 View Area . . . 4

2.5.1 View Types . . . 7

2.5.1.1 Multiplanar Reconstruction View . . . 8

2.5.1.2 Intensity Projection View . . . 8

2.5.1.3 Volume View . . . 10

2.5.1.4 Surface View . . . 10

2.5.1.5 X-Ray Simulation View . . . 11

2.5.1.6 Cutaway View . . . 12

2.5.1.7 CAD View . . . 13

2.6 Toolbar . . . 15

2.6.1 View Toolbox . . . 16

2.6.1.1 Select Tool . . . 16

2.6.1.2 View Pan Tool . . . 16

2.6.1.3 View Zoom Tool . . . 16

2.6.1.4 View Rotate Tool . . . 16

2.6.1.5 View Reset Command . . . 17

2.6.1.6 Region Of Interest Tool . . . 17

2.6.1.7 Lookup Table Edit Tool . . . 17

2.6.1.8 Slice Tool . . . 18

2.6.1.9 Delete Command . . . 18

2.6.2 Segmentation Toolbox . . . 18
2.6.2.1 Segmentation Wizard . . . 18
2.6.2.2 Filter . . . 18
2.6.2.3 Segmentation Tool . . . 19
2.6.3 Labels Toolbox . . . 19
2.6.3.1 New Label . . . 19
2.6.3.2 Merge Labels . . . 19
2.6.3.3 Paint Tool . . . 20
2.6.3.4 Fill Hole Tool . . . 20
2.6.3.5 Separate . . . 20
2.6.3.6 Split Tool . . . 20
2.6.3.7 Cut Tool . . . 21
2.6.3.8 Symmetry Tool . . . 21
2.6.3.9 Split Tool Illustration . . . 21
2.6.3.10 Cut Tool Illustration . . . 25
2.6.4 Reduction Toolbox . . . 31
2.6.4.1 Translate Tool . . . 31
2.6.4.2 Pivot Tool . . . 32
2.6.4.3 Rotate Tool . . . 33
2.6.4.4 Reset . . . 34
2.6.4.5 Add Screw Tool . . . 34
2.6.4.6 Add Fixation Plate Tool . . . 35
2.6.4.7 Measure Tool . . . 35
2.6.4.8 Screw Widget . . . 35
2.6.4.9 Fixation Plate Widget . . . 37
2.6.5 Objects . . . 38
2.6.6 Selection Properties . . . 39
2.7 Main Menu . . . 39
2.7.1 File . . . 39
2.7.2 Edit . . . 40
2.7.3 View . . . 40
2.7.4 Help . . . 41
2.8 Objects . . . 41
2.9 Options Dialog . . . 42
2.10 Additional Features . . . 42
2.10.1 Display Calibration . . . 42

2.10.2 Grid Lines 42
2.10.3 Anaglyph Stereo 43
2.10.4 Collision Detection 43
2.10.5 3D Connexion mouse 43

3 Tasks **45**
3.1 Segmentation 45
3.1.1 Importing Examination 45
3.1.2 Filtering Dataset 46
3.1.3 Region Of Interest (ROI) 46
3.1.4 Segmentation 46
3.1.5 Further Processing 46
3.2 Reduction 46

4 Activation **47**

A Terminology **49**

CHAPTER

ONE

USER'S MANUAL

EBS is a software application for preoperative planning of bone fracture medical procedures based on a real patient data.

EBS contains a powerfull DICOM viewer with built in surgery planning, simulation and analysis module. In addition to standard medical views like MPR, MIP, MinIP, IntIP, Volume, SSD it supports simulated X-Ray which, Cutaway and CAD view. Simulation mode makes it possible to move bone fragments and fixate them using screws and fixation plates. Various measurements can be made on so prepared reduction plan.

This manual is a guide through the concepts and building blocks of the EBS. It also serves as a reference for a standard application procedures. It starts off by describing User Interface and then moves on to a standard Tasks. Terminology is located at the end.

Note that to access full functionality EBS has to be activated.

CHAPTER

TWO

USER INTERFACE

EBS main window comprises of a document view area on the right hand side, a toolbar on the left hand side, and main menu at the top of the window.

Document viewing and editing is done by executing commands available from toolbar and menu, using the tools activated from toolbar or by manipulaing widgets inside views directly.

2.1 Mode

EBS has different modes which determine how objects are displayed and which tools and commands are available. The mode can be selected on the top of the toolbar.

Segmentation is a process of labeling dataset and creating 3D model. When in segmentation mode all objects will be as found/labeled on dataset. It is not possible to move objects in this view and implants are not shown.

Reduction contains simulated view and thus shows moved bone fragments. It also shows all the implants. Dataset in reduction view is calculated from original dataset taking into account all possibly moved parts.

Top right hand side corner of view contains a description of simulated parts; e.g.: "Sumulated Reduction, Implants" is to be interpreted as: the view contains fregments which have been moved and there are also some implants inserted.

2.2 Command

Command is executed as soon as button is clicked or menu item selected. For the commands which work on objects the target object has to be selected before command is triggered. To delete an object, the object has to be selected first and only than should delete button be clicked. Objects can be selected in Object List or in any of the views by using Select Tool.

2.3 Tool

Tool is an input mode which defines what action is triggered when mouse is clicked or dragged dragged over the view. A tool may support only certain view types. Only one tool can be active at the time.

To distinguish between tool and command buttons, tool buttons have a triangle icon in bottom right hand corner. Only one tool can be active at any time.

When tool is active it might display additional tool properties panel inside the toolbox.

2.4 Widget

Widget is a visual element that is displayed inside view and can be manipulated by clicking or dragging on one of its handles. As a general rule when both tool is active and widget is present widget has a priority. When mouse is clicked on the widget handle widget will accept the action. Some tools like Lookup Table Editor Tool display additional widgets. Global options can be set using Options Dialog.

Additional EBS features are described in appendix.

2.5 View Area

View area contains panes with views onto the document. Based on selected layout there is one or up to four panes displayed at the same time. View layout can be modified by selecting desired item from the *View|Layout* menu. While in one of the panes *spacebar* toggles between single pane layout and multiple pane layout.

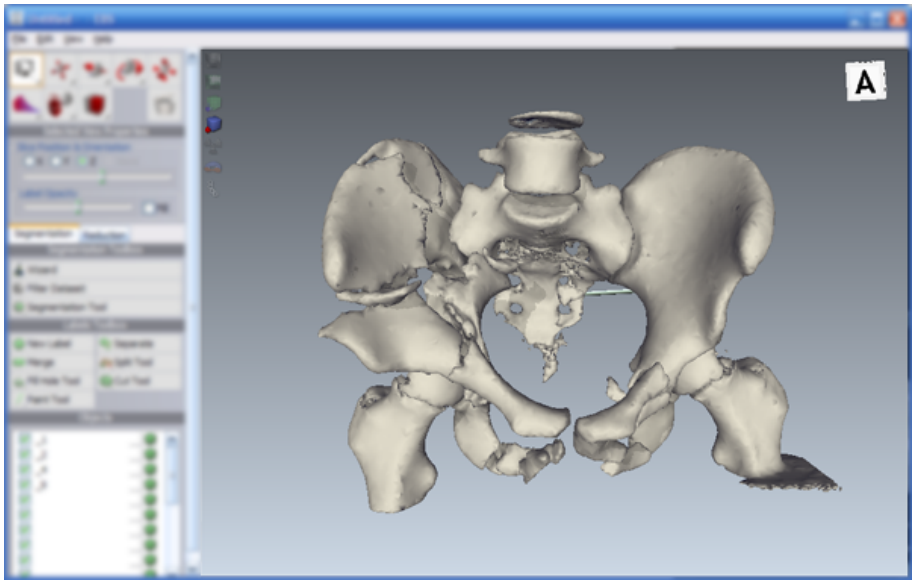


Figure 2.1: Single Pane Layout

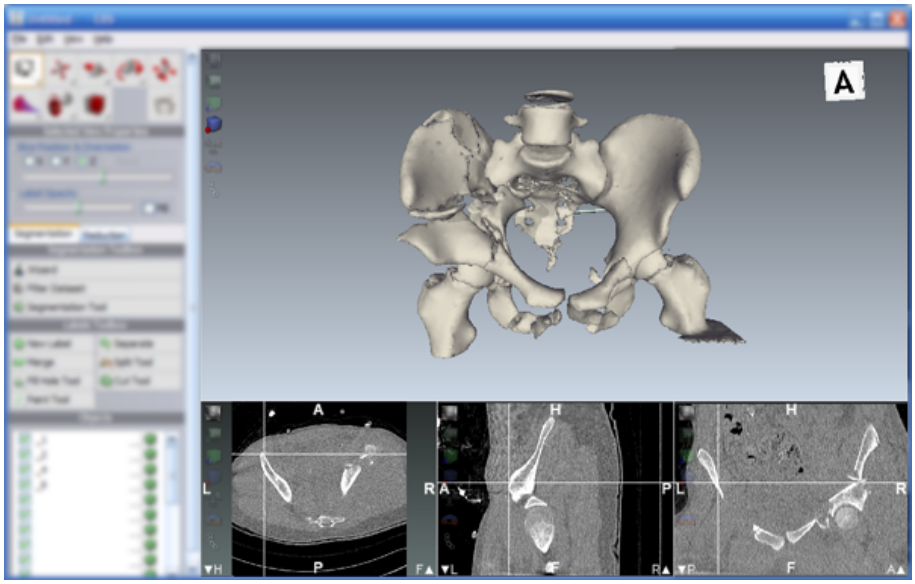


Figure 2.2: Four Panes, Split Bottom

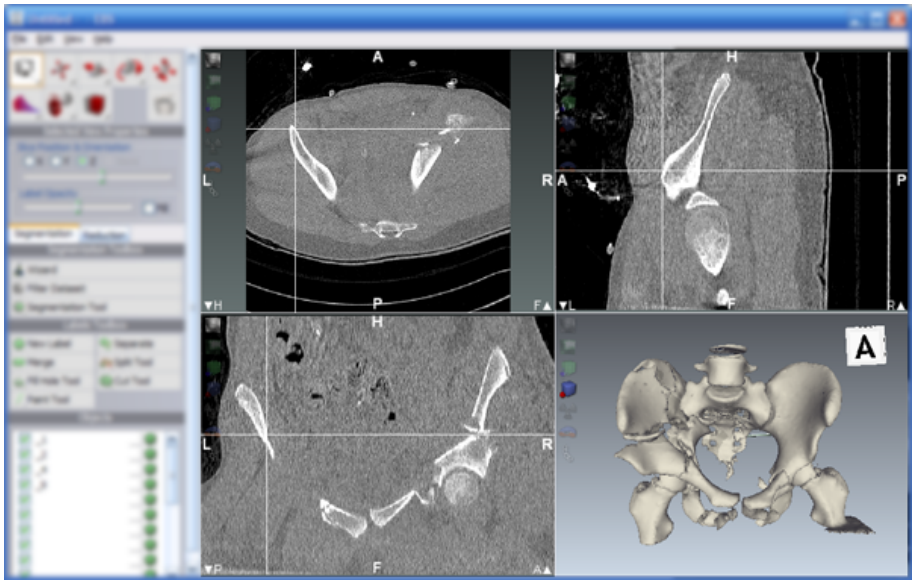


Figure 2.3: Four Panes

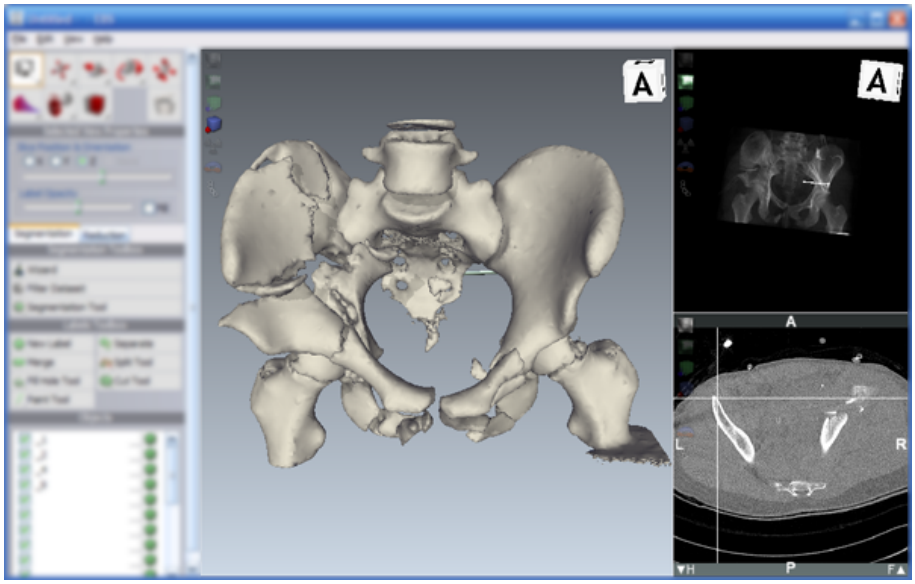


Figure 2.4: Three Panes, Split Right

2.5.1 View Types

Views display contents of a document. Different view types are available, each focusing on different aspect of the data. View type of selected pane can be modified by clicking on view type icon in the top left hand side corner of the view. Alternativelly view type can be chosen by selection one of the options in *Views|Pane Contents* menu.

Figure 2.5: View type icons

Properties for selected view are displayed underneath the View toolbox inside the toolbar. The Selected view properties can be expanded or minimized by clicking on the title. Diffrent properties are displayed based on selected view type.

Some common properties shared among multiple views include:

The views which display dataset slices (Multiplanar Reconstruction View, Shaded Surface View, and Cutaway View):

Slice Section which can be a dataset orientation, oblique or user defined path. Slice orientation is described in a bit more detail in Multiplanar Reconstruction View section.

The slice position slider located underneath slice orientation radio buttons is is used to move among the slices perpendicular to view orientation.

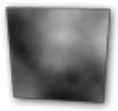
Label opacity controls how labels are displayed inside the slice view. A slider controls label opacity. Opacity of the label mark can be modified from 0% to 100%. In case of 100% no dataset image will be shown underneath the label area. Fill selects if closed contour on the edge of the label or as a filled shape is used to denote label. The 3D views (all except Multiplanar Reconstruction)

3D Orthographic projection selects between ortographic and perspective projection. In perspective projection size of the objects changes with distance from the view. This gives in beter perception of depth relation

among the parts of objects. In case size is important, especially for comparison among different parts of structures, orthographic projection should be used.

Focal length is enabled only when using perspective projection. It is the property of camera which defines angular extent of the observable scene.

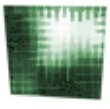
2.5.1.1 Multiplanar Reconstruction View



Multiplanar Reconstruction view displays either a single slice from dataset, planar reconstruction of dataset in arbitrary orientation, or curvelinear reconstruction of dataset using user defined path. The mode can be selected in Slice Section property. In all of the cases images are shown in an isometric 2D view.

Figure 2.6: Multiplanar Reconstruction View

2.5.1.2 Intensity Projection View



Intensity Projection view displays a projection of dataset voxels inside ROI onto a view plane. For each pixel in display image ray is traced in view direction from the eye. Based on selected transfer function the value for output pixel is calculated from voxels intersected by each ray as:

MIP Maximum Intensity Projection shows the maximum voxel intensity on ray path.

MinIP Minimum Intensity Projection shows the minimum voxel intensity on ray path.

Integrate shows the sum of voxel intensities on ray path. The result obtained is 2D XRay image.

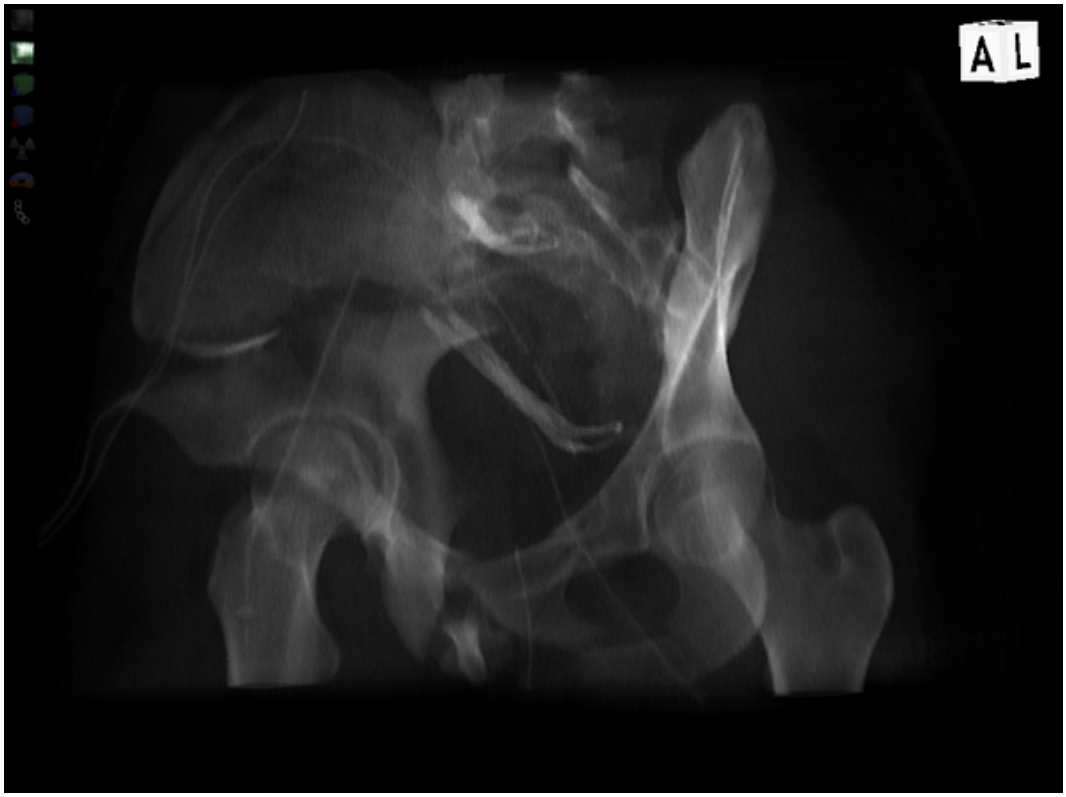


Figure 2.7: Intensity Projection View with Integrate transfer function

Additional properties for Intensity Projection View are:

Clip low level is available only with Integrate projection function. When checked integrating function will ignore all sample values which are below specified low threshold value. Enabling this will display bone fragments with better contrast.

Overly Implants will overlay fixation plates and screws on top of the Intensity projection image. Since the Intensity Projection always displays state as determined by examination, implants might be in wrong location if the bone fragments have been moved after reconstruction.

With Display Implants in color checked the color property of implant will be used to render implant instead of value based on lookup table assigned to view.

2.5.1.3 Volume View

Volume View displays direct volume render of dataset. A ray is cast for each pixel in output image in view direction to create a shaded version of dataset. The apperance of output image greatly depends on selected transfer function. Transfer function can be selected and modified using Lookup Table Edit Tool .

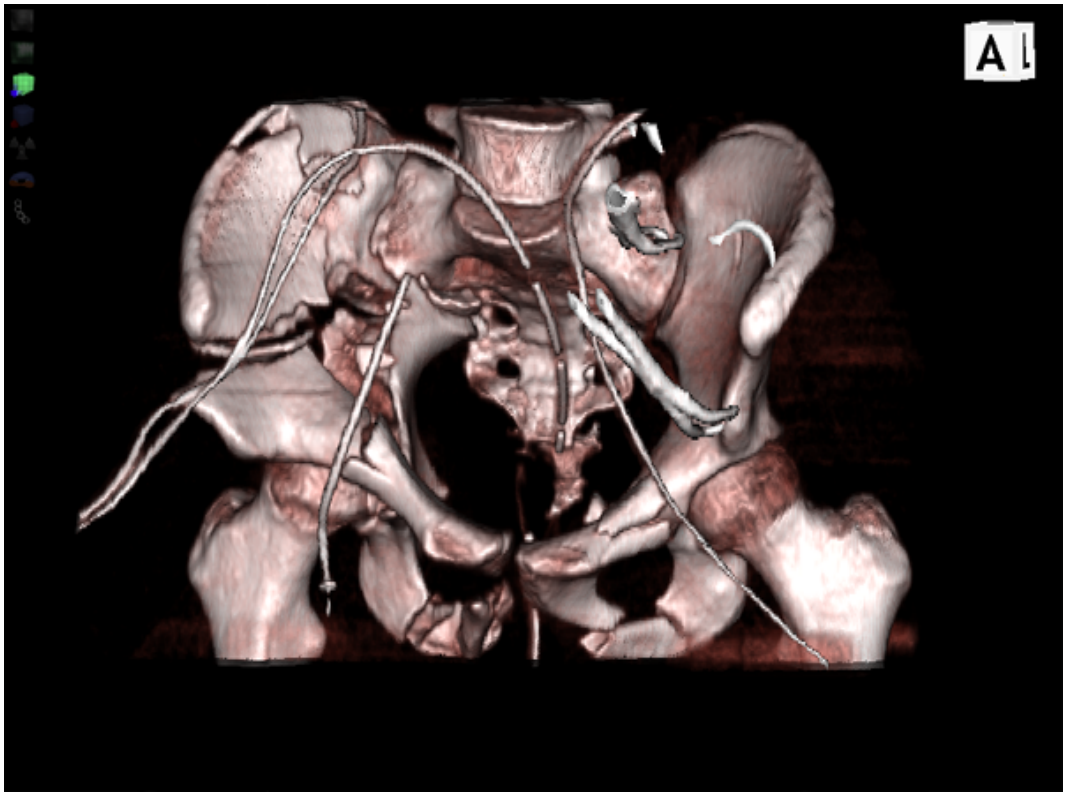


Figure 2.8: Volume View

2.5.1.4 Surface View

Surface View displays shaded surfaces generated from dataset in a segmentation process.

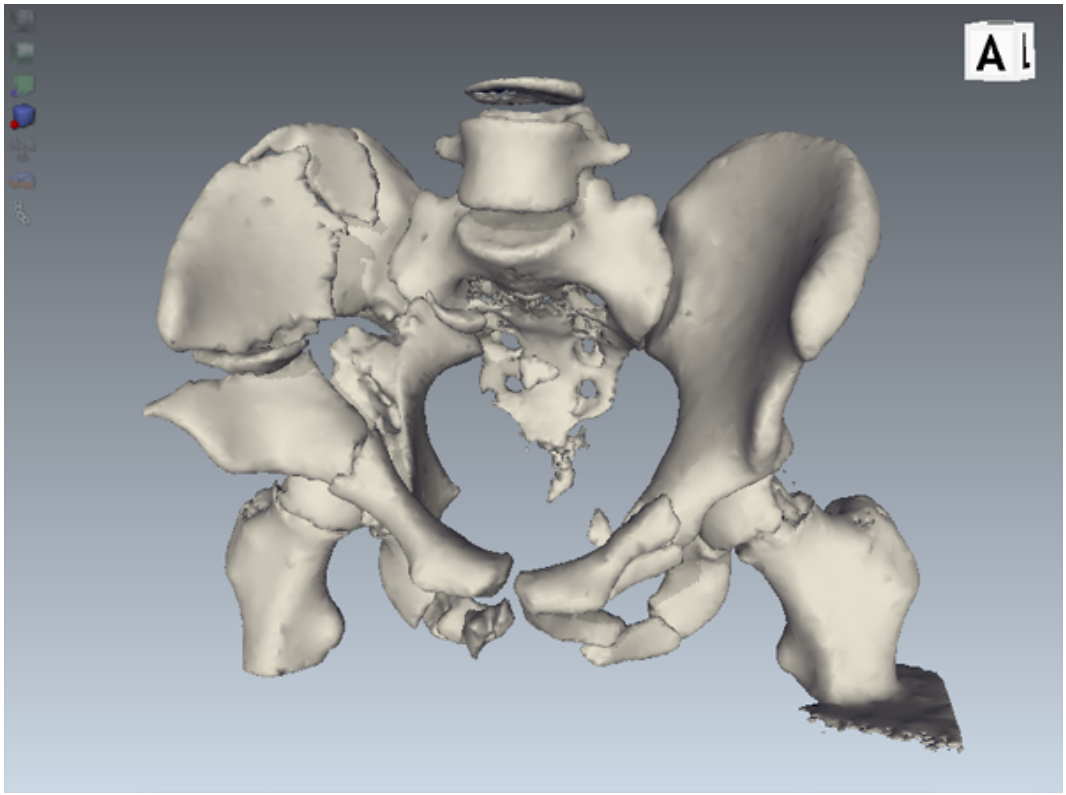


Figure 2.9: Surface View

2.5.1.5 X-Ray Simulation View

X-Ray view displays X-Ray simulation based on surfaces. X Ray simulation does not give physically accurate image as it is based on following assumptions:

All objects are of homogeneous material. Attenuation depends only on thickness.

Visualization is based on sufaces. It does not include data that is present in the original dataset, but has not been captured by segmentation. Fissures than have not been captured in the process of segmentation will not be visible.

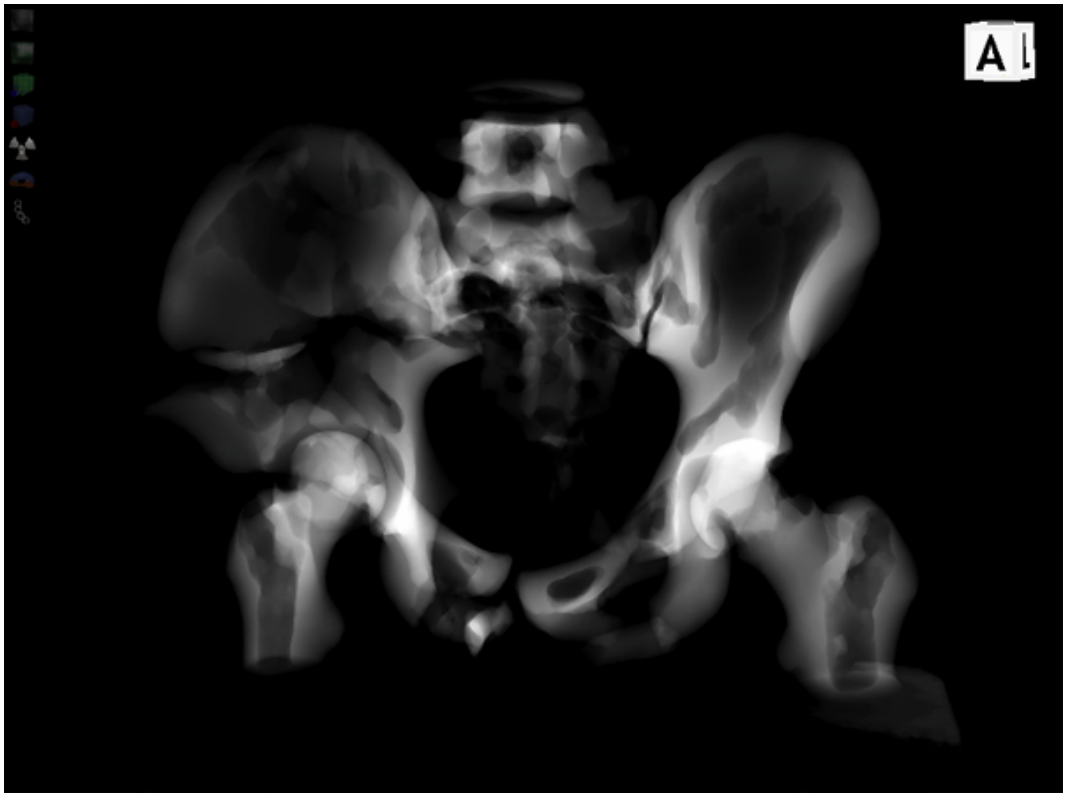


Figure 2.10: X-Ray Simulation View

Additional properties for X-Ray Simulation View include:

Power.

Negative.

Implants In Color renders screws and fixation plates in color assigned to object.

Draw Selected Object Edge renders object edge.

2.5.1.6 Cutaway View

Cutaway view display section trough the 3D model following the screw axis.
A screw has to be selected for this view to work.

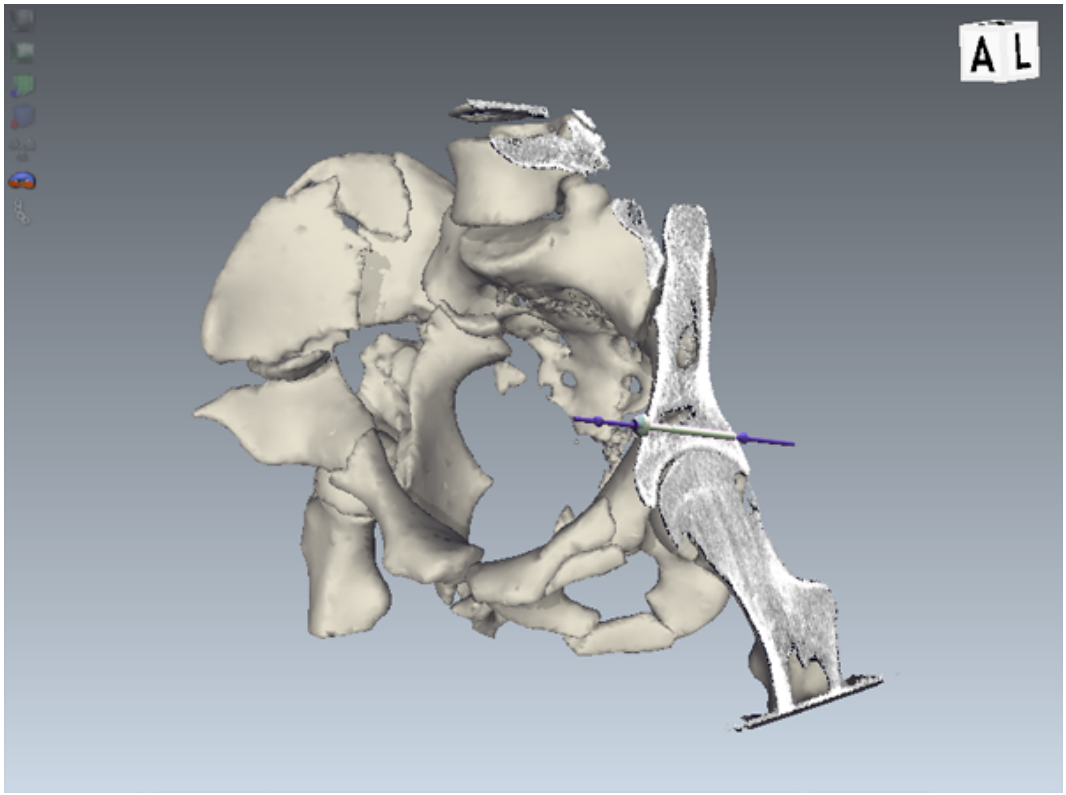


Figure 2.11: Cutaway View

Additional properties for Cutaway View include:

Lock Cut Direction fixes current section plane so that it doesn't move with camera anymore.

2.5.1.7 CAD View

CAD view shows fixation plate from different sides in orthographic projection. This view can be used as a reference for bending the plate.

A fixation plate has to be selected for this view to work.

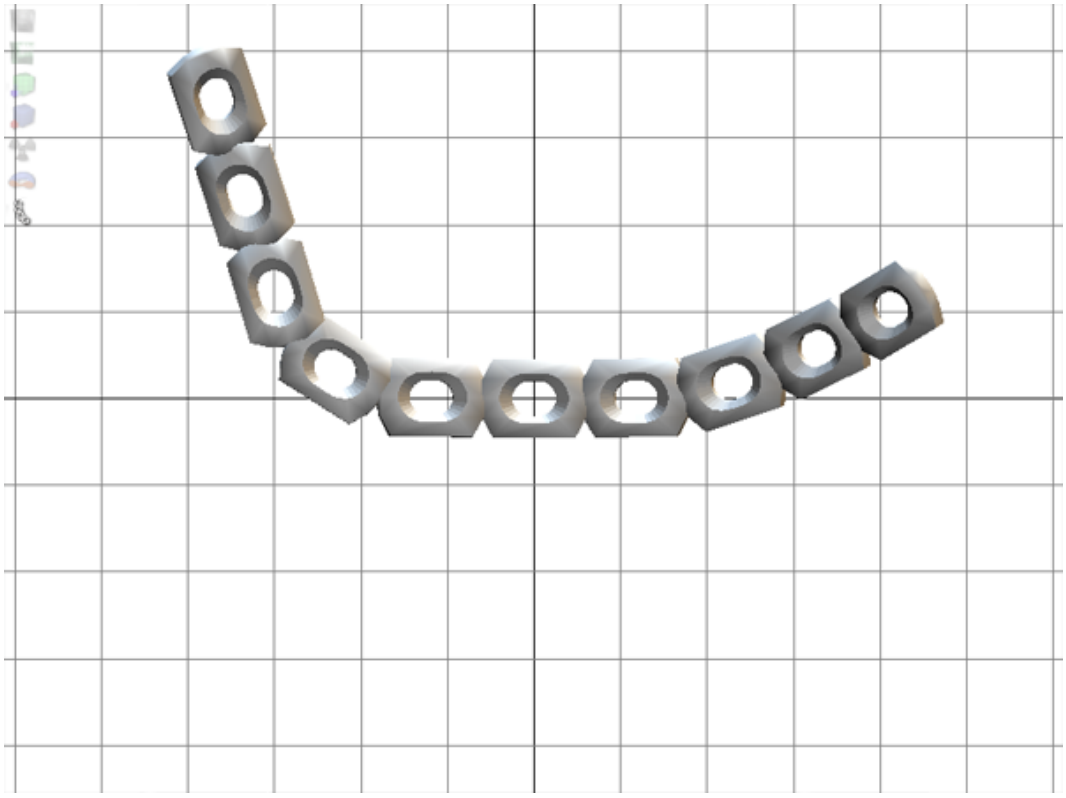


Figure 2.12: CAD View

Properties for CAD View:

Lock Display Scale to 1:1: by selecting this option fixation plate is displayed on screen in real size. Display scale can be calibrated in Options dialog.

2.6 Toolbar

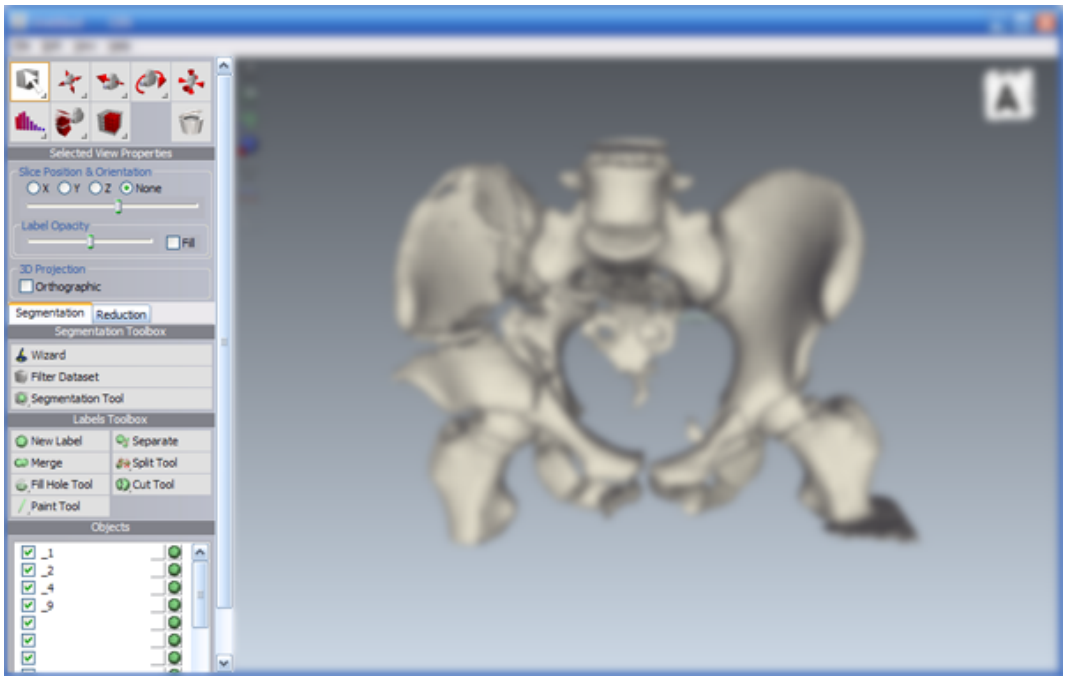


Figure 2.13: Toolbar on the left hand side

Toolbar contains functions - tools, commands, and properties - for controling display and to edit the document. Functions are logically grouped into a few distinct toolboxes.

The top of the Toolbar is always occupied by View Toolbox. View Toolbox contains tools and commands for changing view properties. Properties of selected view are displayed directly underneath.

Below the selected view properties is a task selector which shows additional toolboxes based on task selected:

Segmentation :

Segmentation Toolbox

Labels Toolbox

Reduction :

Reduction Toolbox

Other panels in Toolbox are:

Object List displays list of objects in the document.

Selection attributes display when object with exposed properties is selected.

Some tools display additional property panels when they are activated.

2.6.1 View Toolbox

View Toolbox contains tools and commands for modifying view properties such as eye-point, zoom and slice position.

2.6.1.1 Select Tool

Shortcut: Q Click on label in Dataset or 3D view to select it. Hold Shift while clicking to add to selection or Ctrl to remove object from selection. An alternative way to select objects is by clicking in the items in Objects box in the toolbox.

2.6.1.2 View Pan Tool

Shortcut: X

Click and drag to pan the view.

This tool can be temporarily activated by holding Alt + middle mouse button.

2.6.1.3 View Zoom Tool

Shortcut: C

Click and drag to zoom the view.

This tool can be temporarily activated by holding Alt + left and middle mouse button.

2.6.1.4 View Rotate Tool

Shortcut: V

Click and drag to rotate the 3D view. In dataset view this tool changes view projection.

Figure 2.14: Viewpoint widget

Viewpoint widget can also be used to to change the viewpoint: click on surface to rotate the viewpoint to one of the predefined view orientations or drag to rotate freely.

This tool can be temporarily activated by holding Alt + left mouse button.

2.6.1.5 View Reset Command

Click to reset the selected view to default.

2.6.1.6 Region Of Interest Tool

Define region of interest (ROI) - a volume which is used in further processing. ROI can be defined by manually by entering coordinates in tool panel or by dragging a mouse in dataset view. Drawing region in dataset view will modify only two dimensions of ROI, dimensions which are displayed in the view with the third one - depth - left unmodified. To draw all three dimensions bounding box has to be drawn in two dataset views displaying different orientation. Region is indicated by red rectangle.

2.6.1.7 Lookup Table Edit Tool

Shortcut: L

Lookup table defines a mapping between a scalar value and display color. EBS uses lookup table to transform dataset values for display of slice, to map values calculated in intensity projection view or to define color and opacity for for volume rendering.

Window center and width define extent of lookup table. Colors inside the window can be defined using gradient points. All colors outside the window assume either low color in case the value is below lower limit of the window or high color in case value is above upper limit of the window. Window center can be quickly changed by dragging mouse horizontally in display region. Window width is changed by draging mouse vertically in display region. Window center and extents are also denoted in gradient bar as vertical lines. They can be dragged by mouse.

Inside window gradient points can be added by clicking anywhere in the empty area or removed by dragging gradient point gradient bar. The color for specific gradient point can be defined by clicking on the color bar bellow the gradient bar.

Vertical position of gradient point denotes opacity. This is currently only used in Volume render.

2.6.1.8 Slice Tool

Shortcut: Z

Click and/or drag mouse in a view to change the slice position. In slice and 3D view mouse click or drag will display slice at the position pointed by mouse.

This tool can be also temporarily activated by clicking on the middle mouse button.

2.6.1.9 Delete Command

Delete selected objects.

2.6.2 Segmentation Toolbox

2.6.2.1 Segmentation Wizard

Wizard opens a new tool panel and guides a user trough steps of segmentation process as described in Segmentation task.

2.6.2.2 Filter

Filter the dataset with low-pass filter. Dialog box offering filters is shown. There are 3 distinct smoothing filters available:

Recursive Gaussian - this filter is using ITK RecursiveGaussianImageFilter filter to process the dataset.

Gradient Anisotropic Diffusion - this filter is using ITK GradientAnisotropicDiffusionImageFilter to process the dataset.

Curvature Anisotropic Diffusion - this filter is using ITK CurvatureAnisotropicDiffusionImageFilter to process the dataset.

2.6.2.3 Segmentation Tool

Segmentation tool creates initial label from the dataset based on voxel values. The tool sets a threshold value for the threshold filter. The threshold edge is drawn on the slice. Segmentation will be executed with a click on Apply button in the tool panel. Based on selected options some of the following filters might be executed on the label as a post processing step:

Opening - ITK BinaryMorphologicalOpeningImageFilter

Voting Erode - ITK VotingBinaryHoleFillingImageFilter where background value is set to label and foreground value is set to empty space effectivelly reversing operation of hole filling - i.e. filter is clearing the label.

Hole filling - ITK VotingBinaryIterativeHoleFillingImageFilter followed by GrayscaleFillholeImageFilter It is recomended to Select at least one opening filter as this will remove small isolated fragments which are usually artifacts of thresholding. **Clear all existing labels** will remove labels that are already there before the filter is run.

2.6.3 Labels Toolbox

Labels are parts of whole volume which are of interest. For the most part labels can be interpreted as bone fragments. EBS offers tools to create and manipulate labels. Initial label is usually created with Segmentation Tool.

2.6.3.1 New Label

Create new, empty label.

2.6.3.2 Merge Labels

Merge selected labels into a new label.

2.6.3.3 Paint Tool

Manually paint selected label. Painting is done in Dataset view. The tool shows options box with following settings:

Paint over defines which objects to paint over.

Clear label when set painting will clear the label.

Size defines size of paintbrush in voxels.

3D when selected the painting is done in multiple slices at once.

Isotropic takes voxel physical size in each direction into account when size is defined.

Round or **Square** defines a brush shape.

2.6.3.4 Fill Hole Tool

Click on hole to fill it. The tool works only on a single slice. The tool will not perform when hole is not closed.

2.6.3.5 Separate

Move spatially un-connected volumes in selected label into separate labels.

2.6.3.6 Split Tool

Split label into multiple labels based on seed points. Based on dataset labels grow from seed points. The seed points can be defined in dataset or 3D view. When seed point is clicked in 3D view it may move away from clicked point. This is to assure the optimal placement. Verify that seed point is still inside object to be separated. Split Tool uses ROI. For further instructions see an example.

2.6.3.7 Cut Tool

Cut label by drawing a cutting plane. One or more cutting planes can be defined by clicking on the 3D view. Object separated will lay in one of the partitions of the cutting planes. For further instructions see an example.

2.6.3.8 Symmetry Tool

Create a mirror copy of a selected label. Arbitrary mirror plane can be defined using Symmetry widget tool. The tool comprises of two handles representing source and destination point: the mirror plane is calculated so that source point is mirrored exactly into destination point.

The mirror plane splits the space in two parts:

Source half-space which contains source point.

Destination half-space which contains destination point.

Mirror copy is created in destination half-space only using the selected label voxels in source half-space only. The source voxels which already lie in destination half-space will be either ignored or deleted based on **Preserve Source Label Mirror Side** option.

When **Overwrite Existing Labels** is checked mirror copy will be drawn over existing labels possibly erasing parts of them. When this option is not checked mirror copy will fill only empty space not covered by any other label.

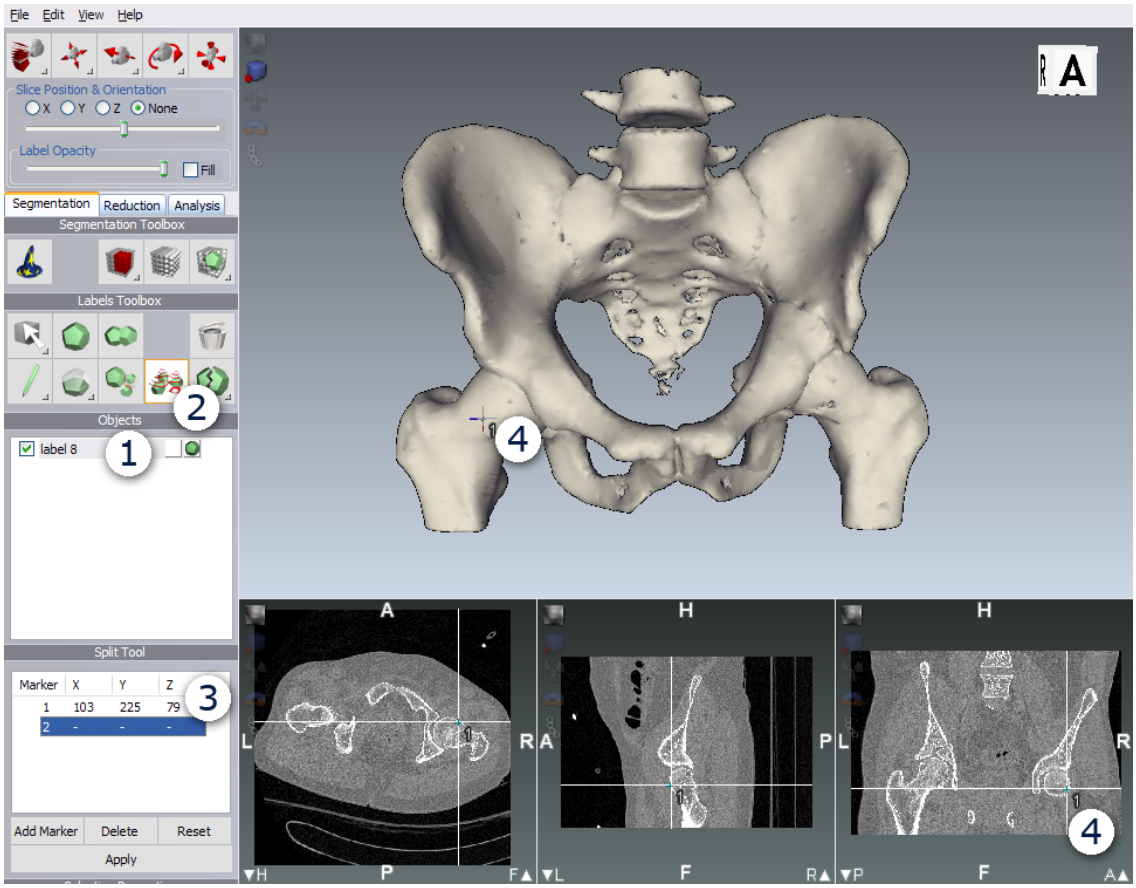
Flip swaps source and destination half-space.

Reset puts mirror plane to default location: mirror in x axis direction.

2.6.3.9 Split Tool Illustration

This is a step-by-step example of Split Tool usage on a case of splitting pelvis into separate bone fragments.

Split Tool can be used to split label based on Dataset. It works by specifying seed points on or in the label from which volumes are grown. The growth is determined by dataset values. The two growth regions will meet in the least dense value in the dataset - usually a crack. Starting point for this example is a label obtained from Segmentation Wizard.

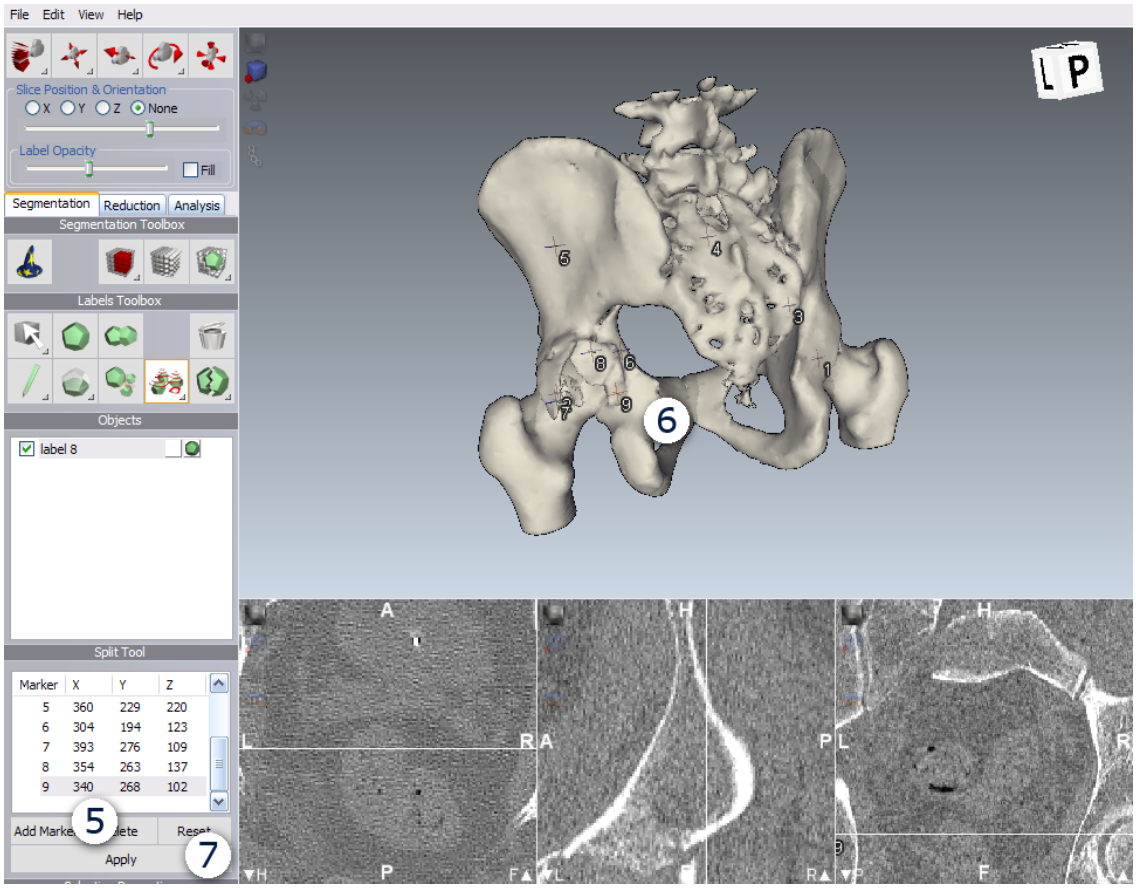


1. Select a label to work on. This can be done by clicking on the item in Objects list, or by activating the Select Tool and clicking on the desired label in 3D view.

2. Select Split Tool. The Split Tool panel will appear bellow. The panel contains list of all markers, buttons for editing markers, and a button for applying the filter.

3. Select one of the markers in the markers list. Double click will navigate Dataset view to that marker.

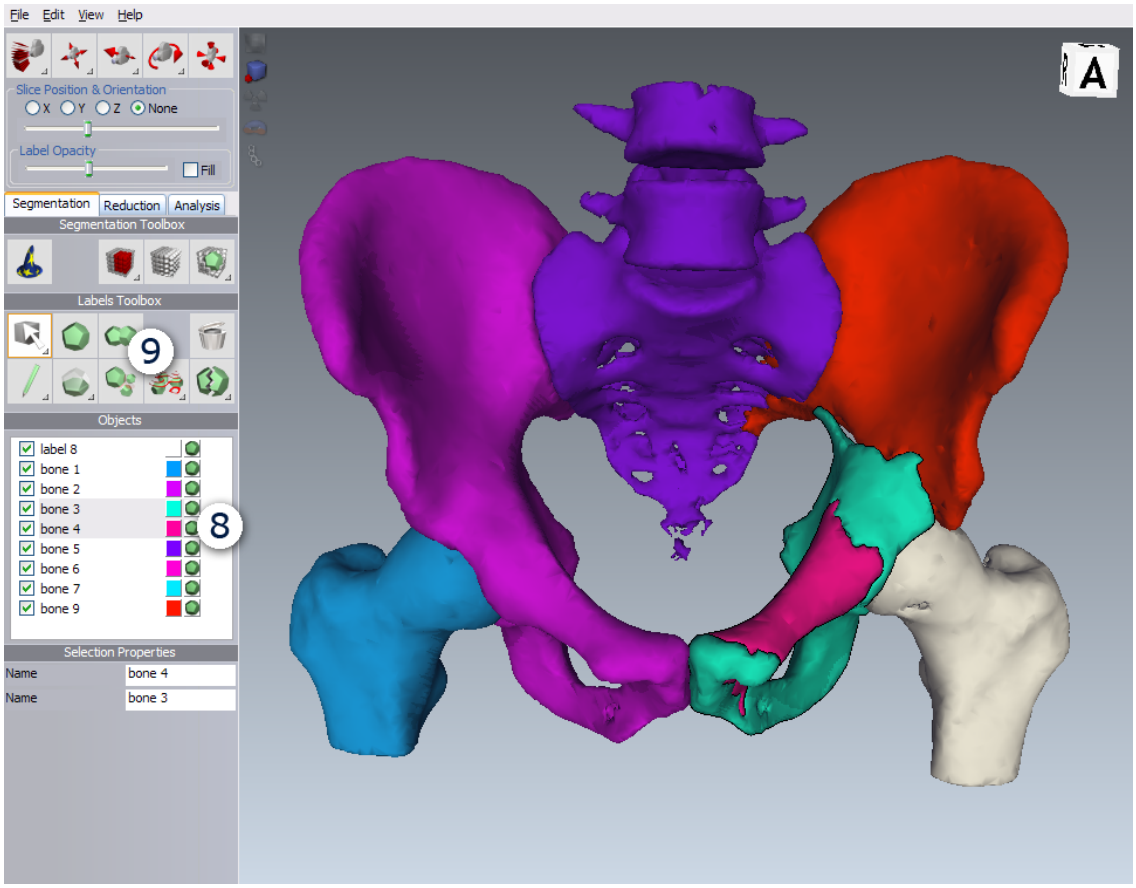
4. Click on the part which should become a separate label. This can be done either in 3D view or in Dataset view. When working in former the point might be moved from click location as to find the optimum placement based on the Dataset. Verify that point is still on or inside the part you clicked on.



5. New markers can be added by pressing Add Marker and

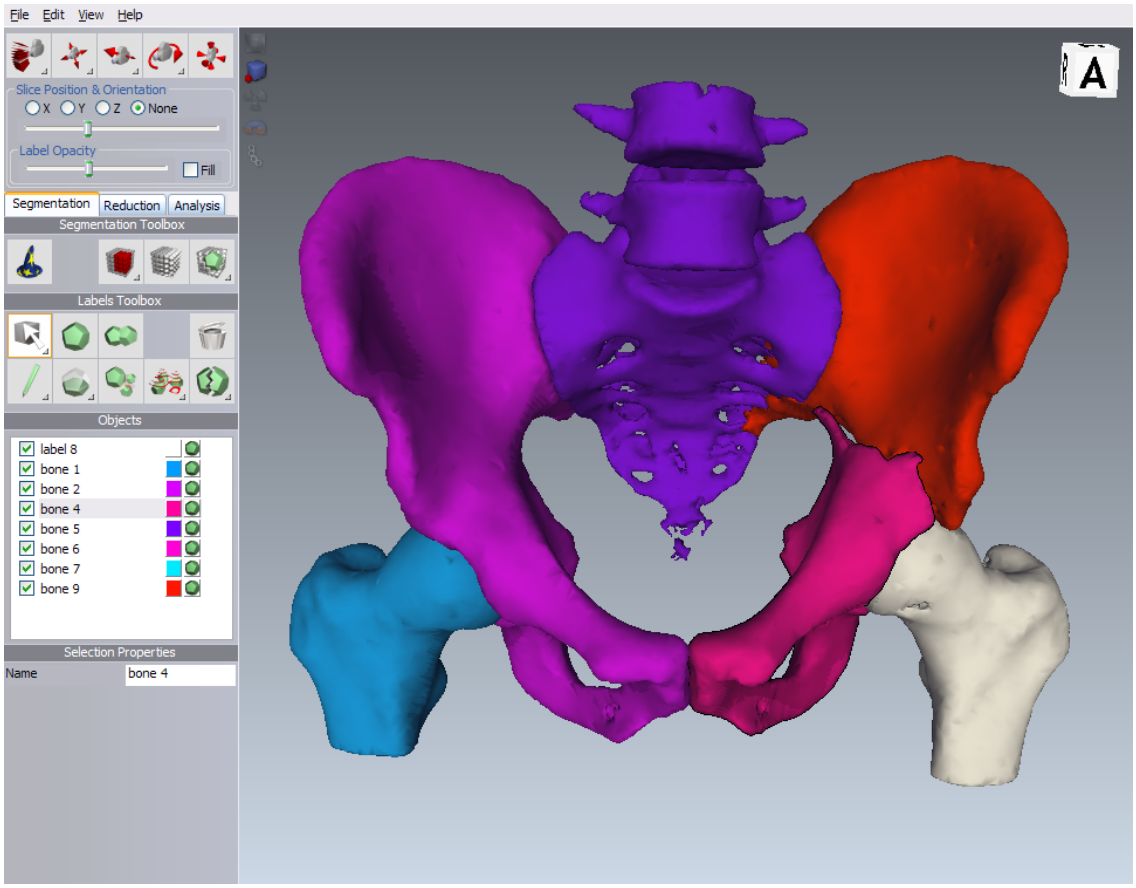
6. defining the marker as presented in step number 4. Repeat steps 5 and 6 for each part which should be separated.

7. Press Apply. Depending on label and dataset size filter processing may take some time.



8. Sometimes the Split Tool doesn't separate some parts as expected. Solution is to either Undo the step and position the markers better or in this case where part has split into two labels (bone3, bone4) process it further. Select the bones which belong together and

9. click on Merge button. This will merge only the two labels.

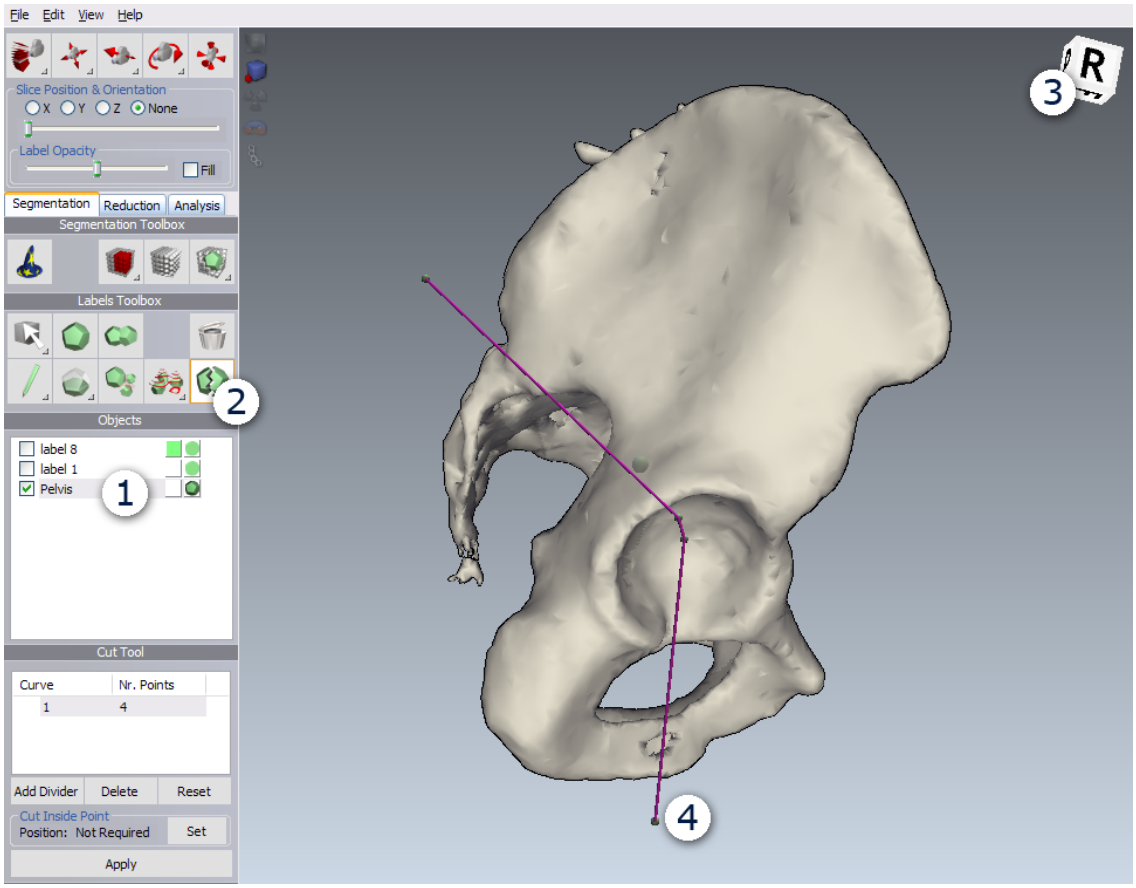


In the image above is the final result. It shows merged labels. If some part of the label was split incorrectly it can always be fixed by merging the labels and re-applying the split tool only on that particular label. Also the label can be further divided by using the Split tool on it even without the Merge.

2.6.3.10 Cut Tool Illustration

This is a step-by-step example of Cut Tool usage on a case of splitting existing pelvis label into two new labels creating an artificial posterior column fracture.

Cut Tool can be used to cut away parts of label. The cut is made by defining a single or multiple dividers drawn in 3D view. Starting point for this example is a label obtained from Segmentation Wizard.

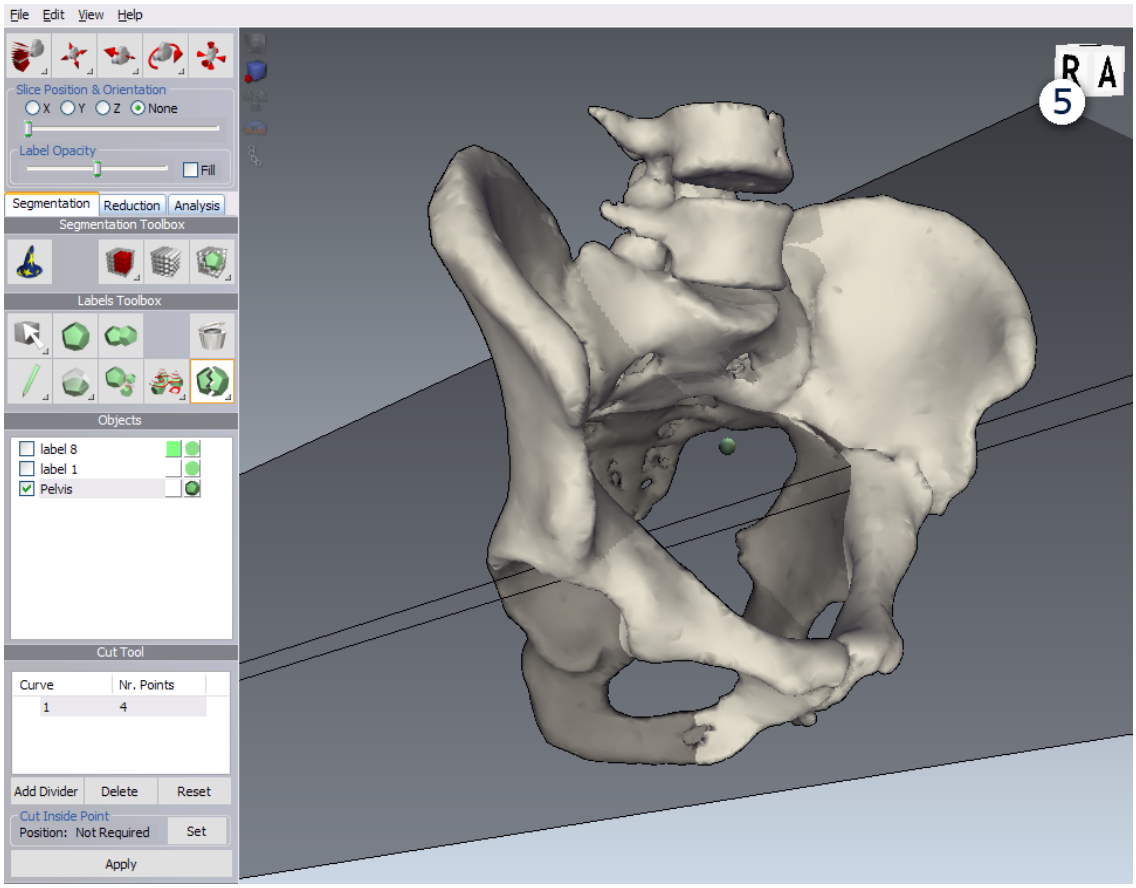


1. Select a label to work on. This can be done by clicking on the item in Objects list, or by activating the Select Tool and clicking on the desired label in 3D view.

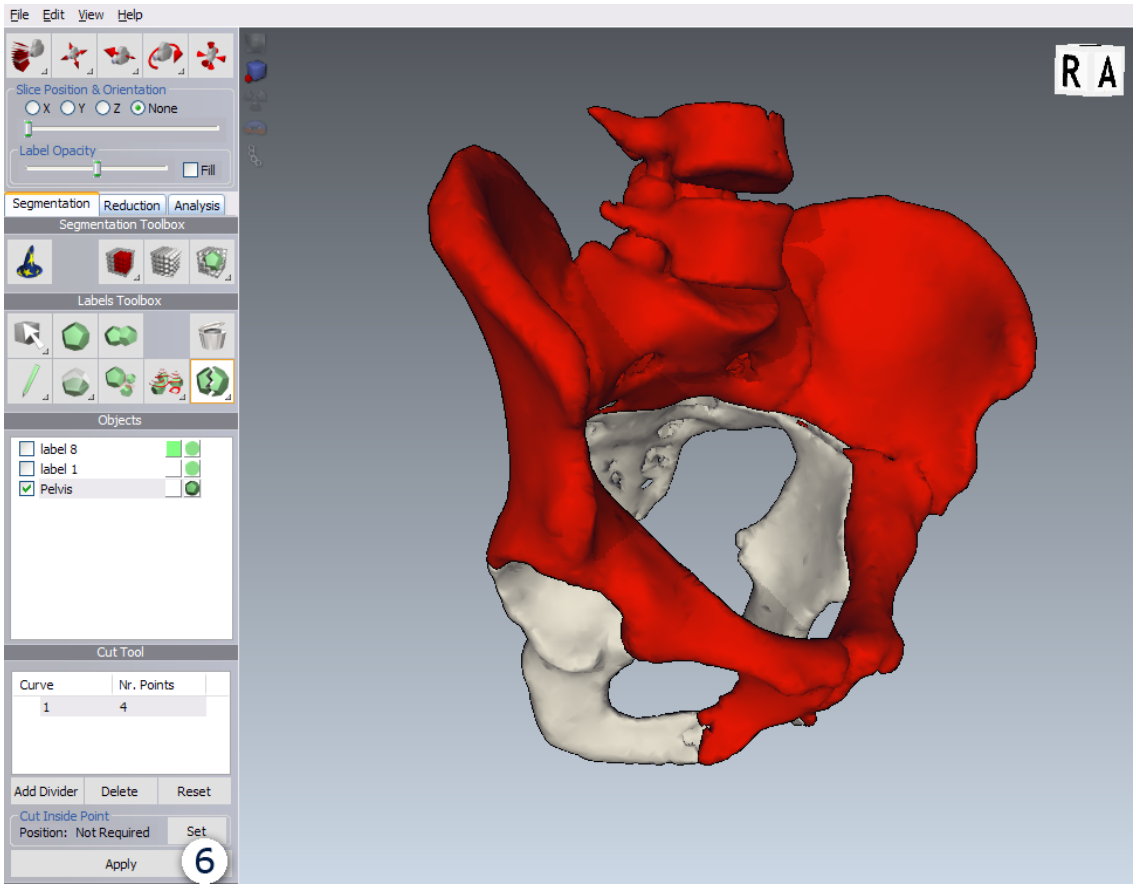
2. Select Cut Tool. The Cut Tool panel will appear bellow. The panel contains list of all dividers, buttons for editing dividers, setting the selected volume and a button for applying the filter.

3. Rotate and align the view. Cut will be made perpendicular to view direction.

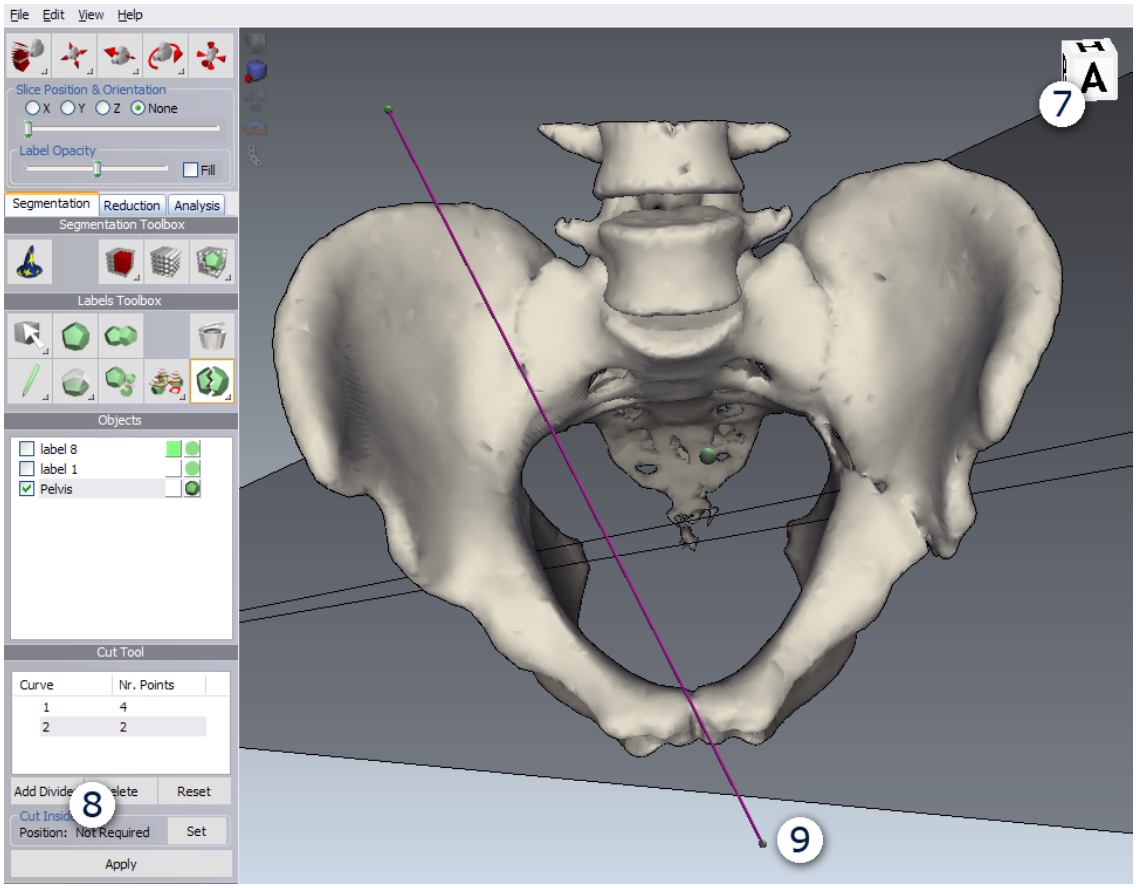
4. Draw the first divider by clicking points in the view area. Divider will split the label. Existing points in the divider can be moved; however it is currently not possible to remove them. Entire divider has to be re-drawn: use Delete followed by an Add Divider to start drawing divider from scratch.



5. Divider plane can be seen on a viewpoint change. Note that divider can be modified only in initial view for the specific divider. In in case one of the divider points is clicked view will be changed back to initial view for that divider. Double click on the divider in the divider list in tool panel will also activate the divider initial view.



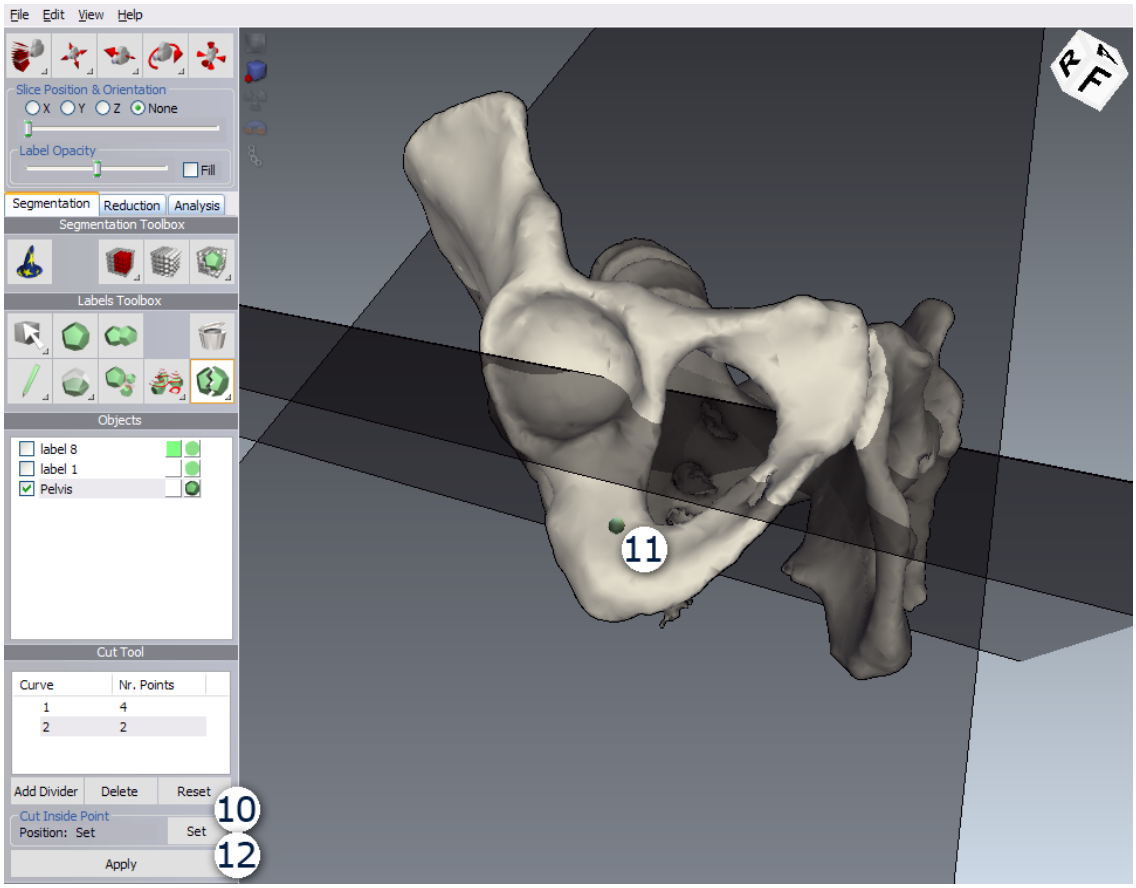
6. Image above shows what would happen in case Apply button was pressed at this moment (Do not press the Apply button). Left side was split together with right posterior column. One way to proceed would be to select the white label and apply separate on it. Since parts we are interested in are not touching each other they will split just fine. After that desired parts can be merged using Merge. For the purpose of this example we will proceed in another way.



7. Rotate view to Anterior position.

8. Click on Add Divider to add another divider.

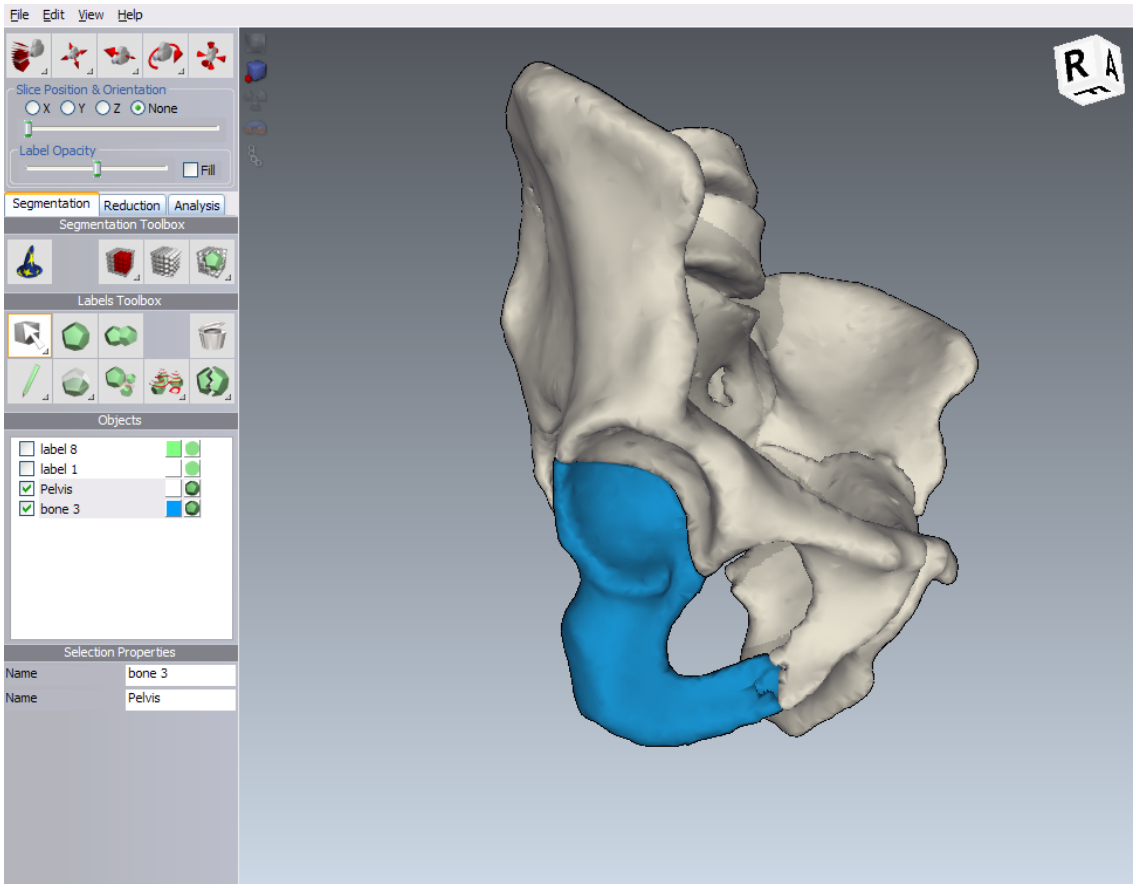
9. Draw the divider.



10. The two dividers divide space into 4 volumes. To specify which of the four volumes should be separated click on Set button and

11. define the point in the volume which should be separated by clicking on it in the 3D view. The element is marked with green sphere.

12. Press Apply button. Final result is displayed in the image below.



2.6.4 Reduction Toolbox

2.6.4.1 Translate Tool

Shortcut: W

Click and drag on handles to translate a selected object.

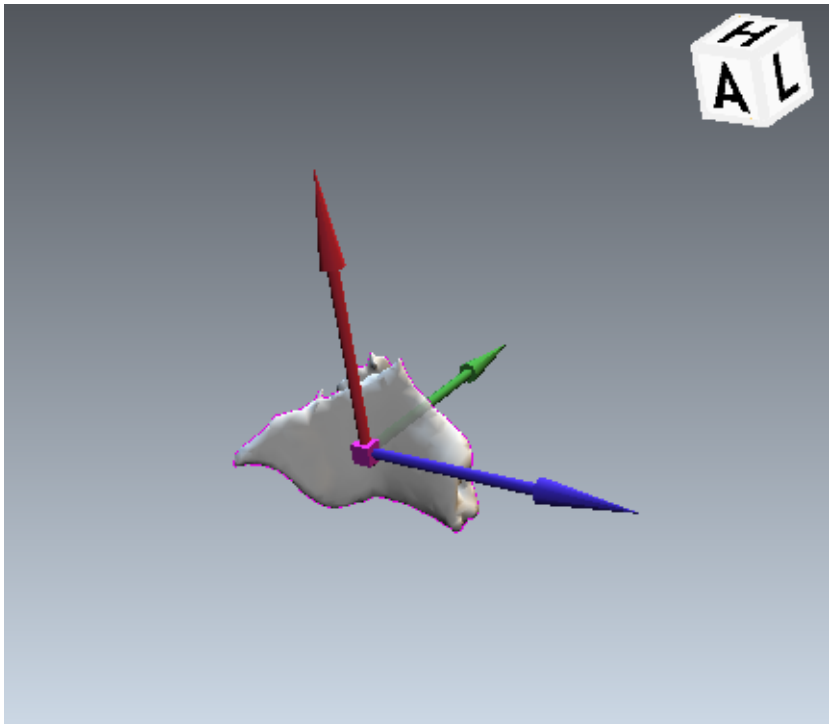


Figure 2.15: Move Widget

Translation widget can be used in following ways:

Dragging one of the arrows will move object in the direction of the arrow.

Dragging cube in the center will move the selected object to the surface of the object below the mouse cursor.

Dragging near the center will move the object parallel to the screen surface.

2.6.4.2 Pivot Tool

Shortcut: E

Click and drag on handles to change center of rotation.

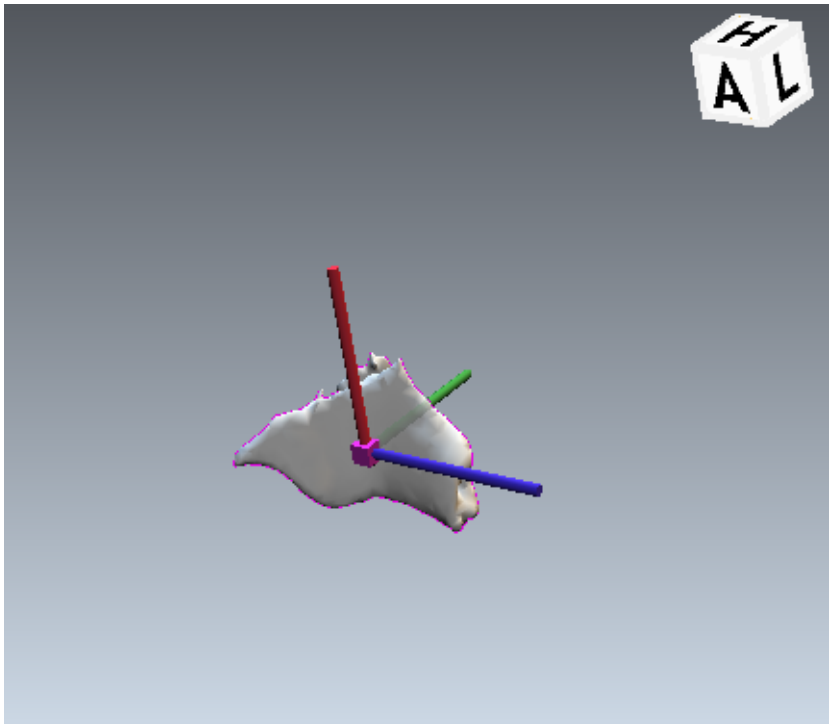


Figure 2.16: Pivot Widget

Pivot widget can be used in following ways:

Dragging one of the lines will move object in the direction of the line.

Dragging cube in the center will move the pivot to the surface of the object below the mouse cursor.

Dragging near the center will move the pivot parallel to the screen surface.

2.6.4.3 Rotate Tool

Shortcut: R

Click and drag the handles to rotate selected object.

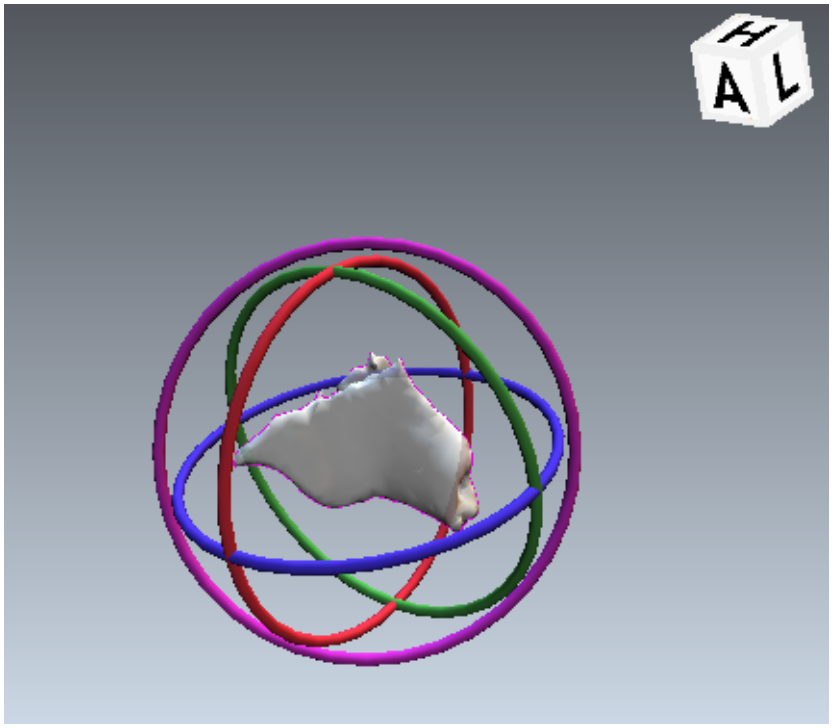


Figure 2.17: Rotation Widget

Rotate widget can be used in following ways:

Dragging one of the circles will rotate object in the axis of that circle.

Dragging the outermost circle will rotate the object in the axis perpendicular to the screen.

Dragging near the center of the widget will rotate object freely.

2.6.4.4 Reset

Reset Transformation.

2.6.4.5 Add Screw Tool

Click on scene to add a new screw. Once screw is created Screw Widget can be used to edit its placement.

2.6.4.6 Add Fixation Plate Tool

Click on scene to add a new fixation plate. Once fixation plate is created Fixation Plate Widget can be used to edit its placement.

2.6.4.7 Measure Tool

Click on scene to draw measure line. At each vertex on the line angle between linear segments is displayed. At the end of the line total line length is displayed. Line is cleared by right mouse click or reset button in toolbox. While tool is active angle between selected two screws is displayed as well.

With Automatic Measures some of the measures are made and displayed automatically:

Moved, Rotated Fragments draws a line between label original position and label curent position for all moved or rotated lables. Additionally distance and angle are displayed as a label over the line.

Angle Between Selected Screws shows angle between selected screws. Angle is measured between first two screws in selection.

2.6.4.8 Screw Widget

Screw widget is a widget for editing screw length and its placement. It is displayed for every selected screw in form of arrows and balls. Those act as a handle and can be clicked and moved with the mouse:

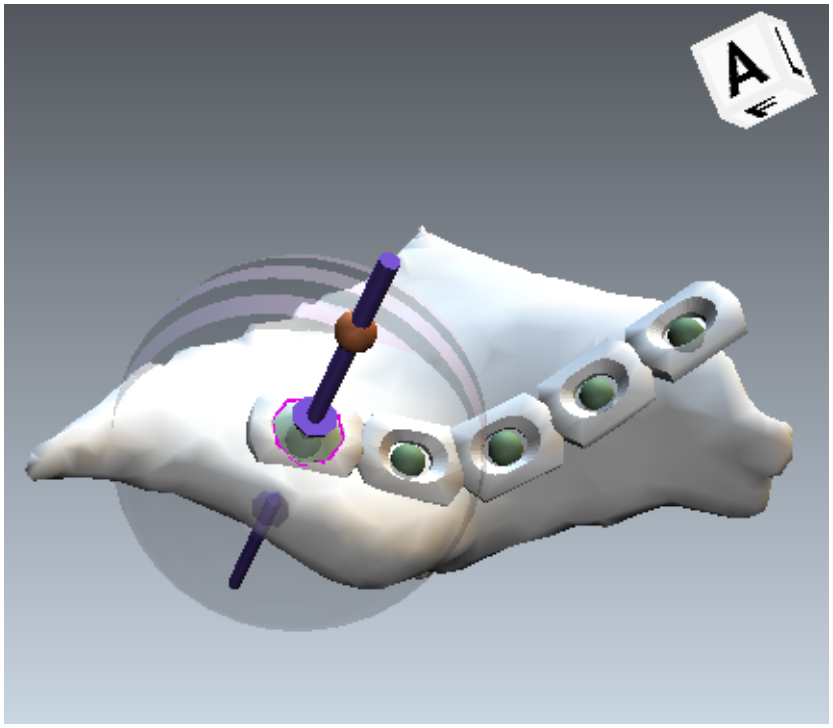


Figure 2.18: Direction Handle

When ball above the entry point arrow is clicked direction indicator is shown enabling change of direction. Screw will automatically adjust the length to the new exit point.

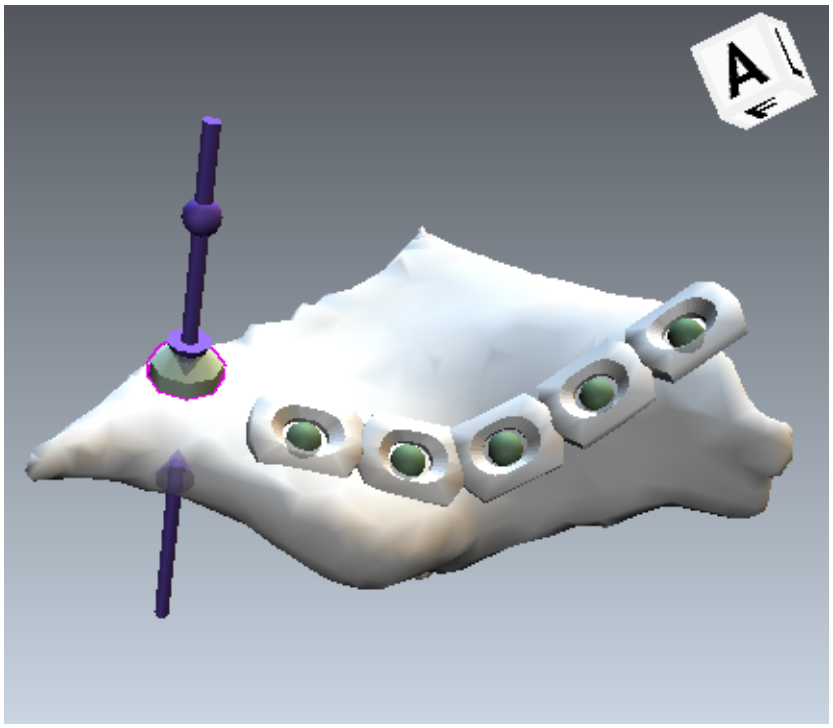


Figure 2.19: Screw widget

When screw exit point arrow is dragged screw exit point is changed.

When screw entry point arrow is dragged entry position is changed and either:

direction is changed so that exit point remains the same (when exit point has been previously manipulated)

direction is perpendicular to the normal at new entry point (when screw direction has been previously manipulated)

Holes in all fixation plates elements contain placement handle. When clicked screw will be placed in fixation plate hole.

2.6.4.9 Fixation Plate Widget

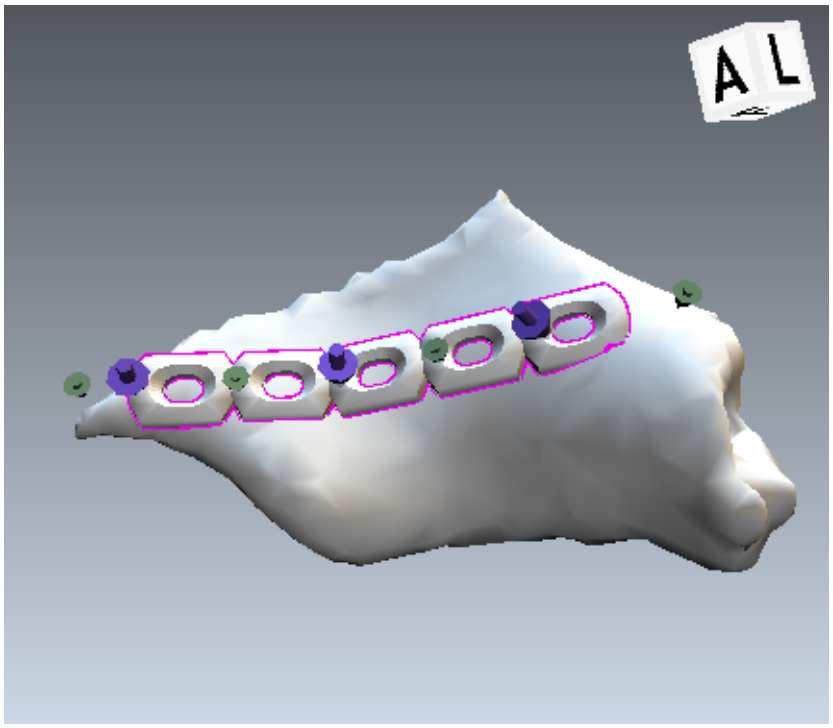


Figure 2.20: Fixation Plate Widget

Fixation plate widget is a widget for editing fixation plate placement. It is displayed for every selected fixation plate in a form of set of arrows. The arrows act as a handles and can be clicked on and dragged with the mouse:

Indigo colored arrows annotate existing placement points. By dragging them on a bone fixation plate will change the shape. Dragging the placement arrow off the object will delete it.

Clicking and dragging the green arrow will add a new placement point at the position of the arrow. This can be used to extend the fixation plate without changing the existing shape, when clicking on arrows on either extreme, or to control placement more precise, when clicking one of the inner arrows.

2.6.5 Objects

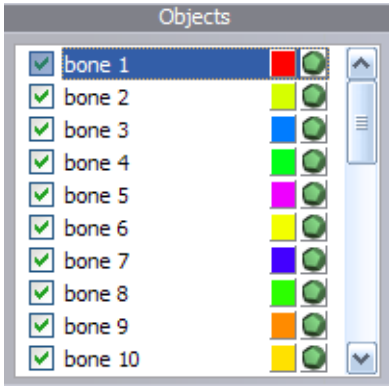


Figure 2.21: Objects list

Objects box contains list of all labels, fixation plates and screws in the document. Each object is represented by one row in the list and contains following information:

Visibility. Object is visible when check box is checked.

Name

Color. Color can be changed by clicking on the color button.

Surface status for labels or object icon for fixation plates and screws. 3Surface status shows the status of surface object in relation to the voxel data of a label. There are 4 status icons:

Mesh is build and it reflects current state of the label.

Label does not contain enough voxels to build mesh from it.

Mesh is not build or contains old state of the label. Build is required. Build process can be started by clicking on the icon.

Mesh is being built.

Mesh is already build, building collision detection mesh.

2.6.6 Selection Properties

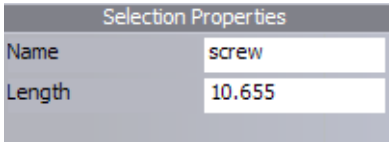


Figure 2.22: Properties for selected Screw

Selection contains properties of selected object or objects. Some of the properties can be modified by typing in new value.

2.7 Main Menu

2.7.1 File

New

Create a new document. Dialog will be displayed to select dataset files location.

Open

Load existing EBS document. EBS documents have .ebs extension.

Save

Save document under existing name.

Save As

Save document under a different name.

Export|Geometry

Export surfaces into 3D mesh file. Following two file formats are supported:

COLLADA (COLLAborative Design Activity) is an interchange file format for interactive 3D applications. COLLADA is managed by the Khronos Group. When COLLADA is selected as export format all visible screws, fixation plates and labels with built surface representation will be exported. The unit of exported scene is millimeter.

STL is a file format native to the stereolithography CAD software created by 3D Systems. STL is widely used for rapid prototyping and computer-aided manufacturing. Each of meshes for selected labels will be exported into separate file. In case there is more than one label selected a separate file with name of the label appended to the selected file name will be used for each label.

Export|DICOM

Save currently displayed dataset. In Reduction mode simulated dataset with moved bone fragments will be exported.

Print

Print currently displayed image in selected view. For CAD view fixation plate bending angles are printed.

DICOM Files|Show Info

Show status of dataset file with source location of dataset files.

DICOM Files|Set Dataset Path

Set location of the dataset files. Available only in cases when the dataset path specified in document is invalid.

DICOM Files|Copy Dataset Files

Copy dataset files referenced in the document to arbitrary folder.

DICOM Files|Move Dataset Files

Move dataset files referenced in the document to arbitrary folder.

Show Metadata

Display DICOM metadata defined in currently loaded dataset. DICOM metadata contain information about the patient and examination details.

Exit

Exit the application.

2.7.2 Edit

Undo

Undo command.

Redo

Redo undone command.

Clear Undo Buffer

This command will release memory used by undo steps. It will also revert filtered dataset to initial state. This command can not be undone.

Due to large size of data EBS might sometime not be able to perform operation for the lack of memory. To release unused memory use *Clear Undo Buffer* and try to execute operation again.

Options

Display options dialog.

2.7.3 View

Layout

Submenu item selects one of the available view layouts.

Pane Contents

Submenu item selects one of the available view types for the selected view pane.

Grid Lines

Toggle grid line overlay.

Onion Skin

Onion skin displays original position and orientation of moved lables in Shaded Surfave Display as a transparent shape.

Stereo

Toggle anaglyph stereo view. Menu has a check box when stereo is enabled.

Eye Separation

Commands under this menu can be used to change the stereo eye separation.

Build Surfaces

Update surfaces for all the labels that have been modified since the surface was last build.

Rebuild Surfaces

Rebuild surfaces for all the labels.

2.7.4 Help

Contents

Display help contents.

Activation

Activate EBS by sending serial number to the EBS activation service. To access full feature set EBS has to be activated.

About

Display application information.

2.8 Objects

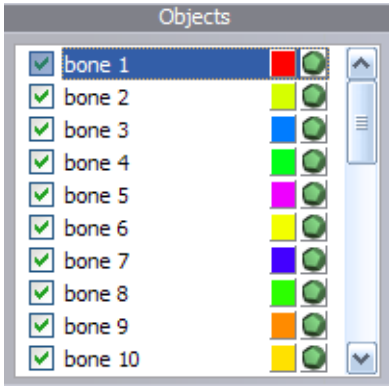


Figure 2.23: Objects list

Objects box contains list of all labels, fixation plates and screws in the document. Each object is represented by one row in the list and contains following information:

Visibility. Object is visible when check box is checked.

Name

Color. Color can be changed by clicking on the color button.

Surface status for labels or object icon for fixation plates and screws. 3Surface status shows the status of surface object in relation to the voxel data of a label. There are 4 status icons:

Mesh is build and it reflects current state of the label.

Label does not contain enough voxels to build mesh from it.

Mesh is not build or contains old state of the label. Build is required. Build process can be started by clicking on the icon.

Mesh is being built.

Mesh is already build, building collision detection mesh.

2.9 Options Dialog

Use options dialog to set application preferences.

2.10 Additional Features

2.10.1 Display Calibration

Operating system does not provide accurate information on display device physical size. To get 1:1 scaling to work correctly display has to be calibrated. Calibration is done in options: *Edit*|*Options*|*Display*|*Calibration* by entering pixel vertical and horizontal size. In case this information is not available physical display device width or resolution can be specified to calculate the pixels size.

2.10.2 Grid Lines

EBS can overlay grid lines to help define spatial relations among the objects. The grid lines are enabled in the main menu *View*|*Grid Lines* or in the options dialog: Edit|Options|Display|Grid Lines.

The options panel enables to select grid lines to be:

Non-Metric: distance between the lines in grid is defined in pixels. Non metric grid is drawn in blue color.

Metric: distance between the lines is defied in milimeters. Metric grid is drawn in green color.

Metric grid can be used to measure physical size of the objects. It works only in views with an orhographic projection. Non-Metric grid can be overlayed on any kind of view. To be sure that grid is always metric select "Metric Gridlines" and uncheck "Allow display of nonmetric gridlines in perspective views".

2.10.3 Anaglyph Stereo

EBS supports 3D stereoscopic display by using anaglyph stereo glasses. Red-cyan colored glasses with red filter over left eye are required.

Figure 2.24: Anaglyph stereo glasses.

Stereo view can be enabled in the options dialog: Edit|Options|View|Stereo or trough the View|Stereo menu.

The stereo effect depends on eye separation. It is advisable that you manually change the eye separation untill image is comfortable to view. The eye separation can be changed using F5 and F6 shortcut keys or by using the Stereo options panel.

Turning on stereo view might decrease color saturation of certain objects to enhance the stereoscopy effect.

2.10.4 Collision Detection

Collision detection prevents moving surfaces into each other. To enable special processing has to be done on mesh objects. The processing step is done in parallel to building mesh.

For collision detection to work NVIDIA PhysX system software hass to be installed: http://www.nvidia.com/object/physx_9.09.0408_whql.html . Note that no special hardware is required to run this software.

2.10.5 3D Connexion mouse

EBS supports 3DConnexion input devices for changing viewpoint and moving objects in the 3D scene. See the 3DConnexion web site for for details on available models: http://www.3dconnexion.com/ .

CHAPTER

THREE

TASKS

EBS workflow comprises of following steps:

Importing examination and creation of surfaces: Segmentation

Reduction and fixation using surface representation: Reduction

3.1 Segmentation

Segmentation is a process of building a 3D surface model from examination represented as volumetric image - stack of image slices. Steps of segmentation are outlined below.

3.1.1 Importing Examination

A first step is to import examination data stored in DICOM format. Examination is loaded by selecting *File|New...* menu and pointing to folder with examination. With option "Include Sub-Folders" all sub-folders of selected folder will be scanned for images. In case there is more than one dataset found in specified folder selection dialog box will appear prompting to select one of the available datasets.

Once dataset is loaded it can be viewed in dataset views.

DICOM metadata such as more detailed patient info and scanning parameters are available trough the menu *File|Show Metadata...*.

Menu *File|DICOM Files|Show Info...* displays short info about the state of dataset and where the images were loaded from. This might be useful moving .ebs documents to a different location.

Location of DICOM files is stored in .ebs document as a relative path reference. When document is saved to different device or media user must take care that DICOM files which document references are moved too. To modify the path to DICOM files *File|DICOM Files|Set Dataset Path...* can be used.

There are two utility commands to copy or move referenced DICOM files to user specified folder under *FIle|DICOM Files*.

3.1.2 Filtering Dataset

Based on scanning protocol used, data might contain too much noise to proceed with segmentation. By filtering dataset high frequency noise is removed. More the data is smoothed, easier will it will be to process further, but possibly important details might be lost.

Filter dialog is shown by clicking the *Filter Dataset* button. There are three smoothing filters available:

Recursive Gaussian

Gradient Anisotropic Diffusion

Curvature Anisotropic Diffusion

Please consult ITK documentation about filter details.

3.1.3 Region Of Interest (ROI)

Processing time increases with dataset size. In case only part of dataset contains structures of interest it is possible to ignore irrelevant parts by defining sub region of the dataset where on which filtering is performed - ROI. ROI is used in Segmentation and some other filters.

3.1.4 Segmentation

Segmentation tags parts of dataset image which contain tissue of interest. Bone extraction is done with value thresholding followed by optional post processing. Segmentation tool is activated with *Segment Tool* button.

With segmentation parts of dataset are selected which contain image. Simple thresholding is used to define areas. There are also three options for object post processing.

3.1.5 Further Processing

Before reconstruction can start bone fragments have to be separated so they can be manipulated independently. Full set of functions available for that purpose is in Segmentation Toolbox.

3.2 Reduction

Reduction is done by moving the bone fragments and adding implants in form of fixation plates and screws. The tools for reduction are available in Reduction Toolbox .

CHAPTER

FOUR

ACTIVATION

To access full functionality EBS requires to to be activated. Following features are not available without activation:

Creation of new document

Saving of existing document

Export

EBS can be activated by filling out a form under *Help|Activate* menu. The dialog will appear whith following information:

Computer ID is unique id of a computer EBS runs on. The data is prefilled and can not be modified. Software has to be activated on each computer separatelly.

Serial Number is a serial number provided to you by Ekliptik.

Name, Company are the custom data describing user and company.

Email is the address which will be used to send activation notification.

Once all of the above data are entered pressing *Get Activation Key* will connect to EBS activation service and request activation key. After a few moments key is automatically filled in and EBS is activated. In case activation fails error message box appears. In case the activation error persists please contact customer support: `support@ekliptik.si`.

Activation requires an active Internet connection. No other data then the data visible in the Activation dialog is transfered to activation service during activation.

APPENDIX

A

TERMINOLOGY

Dataset: Medical examination comprising of a stack of slices.

Label: A set of voxels in dataset. Labels are used to represent elements of interest e.g. bone fragment. Label shape can be visualized in 3D.

Slice: Two dimensional image containing cross-section trough the body.

Voxel: A single pixel, cell in the slice grid.

DICOM: Digital Imaging and Communications in Medicine

ROI: Region Of Interest

LUT: Lookup table

SSD: Shaded Surface Display